

Translation

PATENT COOPERATION TREATY

PCT/JP2003/007577



PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY (Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PCT083JST	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/JP2003/007577	International filing date (day/month/year) 13 June 2003 (13.06.2003)	Priority date (day/month/year) 16 December 2002 (16.12.2002)
International Patent Classification (IPC) or national classification and IPC H01L 29/06, 21/20, 21/203, 33/00, H01S 5/34, 5/50, H01L 21/205		
Applicant JAPAN SCIENCE AND TECHNOLOGY AGENCY		

- This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 10 sheets, including this cover sheet.
- This report is also accompanied by ANNEXES, comprising:
 - ☒ (sent to the applicant and to the International Bureau) a total of 18 sheets, as follows:
 - ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
 - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
 - ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) _____, containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

- This report contains indications relating to the following items:

- ☒ Box No. I Basis of the report
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

Date of submission of the demand 11 June 2004 (11.06.2004)	Date of completion of this report 04 February 2005 (04.02.2005)
Name and mailing address of the IPEA/JP	Authorized officer
Facsimile No.	Telephone No.

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Box No. I Basis of the report

1. With regard to the language, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

- ☐ This report is based on translations from the original language into the following language _____, which is language of a translation furnished for the purpose of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the elements of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

☐ The international application as originally filed/furnished

☒ the description:

pages _____ 1-4, 10-41 _____, as originally filed/furnished
 pages* _____ 5-9/1 _____ received by this Authority on _____ 26 November 2004 (26.11.2004)
 pages* _____ received by this Authority on _____

☒ the claims:

pages _____, as originally filed/furnished
 pages* _____, as amended (together with any statement) under Article 19
 pages* _____ 1-2, 4-9, 12-15, 18-20, 23-25, 27-30 _____ received by this Authority on _____ 26 November 2004 (26.11.2004)
 pages* _____ received by this Authority on _____

☒ the drawings:

pages _____ 1-32 _____, as originally filed/furnished
 pages* _____ received by this Authority on _____
 pages* _____ received by this Authority on _____

☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☒ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☒ the claims, Nos. _____ 3, 10-11, 16-17, 21-22 _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (specify): _____
- ☐ any table(s) related to sequence listing (specify): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (specify): _____
- ☐ any table(s) related to sequence listing (specify): _____

* If item 4 applies, some or all of those sheets may be marked "superseded."

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Box No. IV Lack of unity of invention

1. ☐ In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.
- ☐ paid additional fees.
- ☐ paid additional fees under protest.
- ☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.
- ☒ not complied with for the following reasons:

See supplemental sheet

4. Consequently, this report has been established in respect of the following parts of the international application:

- ☒ all parts.
- ☐ the parts relating to claims Nos. _____

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Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: IV. 3.

The invention described in claims 1, 2, and 4 to 7 pertains to a semiconductor laminate structure having non-uniform quantum dots; the invention described in claims 8, 9, and 12 to 14 pertains to a light-emitting diode using a semiconductor laminate structure having non-uniform quantum dots; the invention described in claim 15 and claims 18 and 19 pertains to a semiconductor laser diode using a semiconductor laminate structure having non-uniform quantum dots; and the invention described in claim 20 and claims 23 and 24 pertains to a semiconductor optical amplifier using a semiconductor laminate structure having non-uniform quantum dots.

The invention described in claims 25 to 29 pertains to a manufacturing method for a semiconductor device using a semiconductor structure having non-uniform quantum dots, but claims 25 to 29 cannot be said to describe a single method applied particularly in order to manufacture the semiconductor laminate structure having non-uniform quantum dots of the invention described in claims 1, 2, and 4 to 7.

(The manufacturing method of the invention described in claims 25 to 29 cannot be considered a method of manufacturing quantum dots which are characterized in that "the different quantum dots are formed from non-uniform quantum dots having both/either different sizes and/or compositions and comprising a compound semiconductor," and that "the non-uniform quantum dots have a plurality of quantum levels corresponding to a plurality of wavelengths which include at least either of ultraviolet light to visible light or infrared light including the 1.3 μm band and the 1.5 μm

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Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: IV. 3 :

band, and which with the input of electrical current,
serve as the emission peak(s).")

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V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1, 2, 4-9, 12-15, 18-20, 23-30	YES
	Claims		NO
Inventive step (IS)	Claims		YES
	Claims	1, 2, 4-9, 12-15, 18-20, 23-30	NO
Industrial applicability (IA)	Claims	1, 2, 4-9, 12-15, 18-20, 23-30	YES
	Claims		NO

2. Citations and explanations

Document 1: Y. Nonogaki et al., "Formation of InGaAs dots on InP substrate with lattice-matching growth condition by droplet heteroepitaxy," *Compound Semiconductors 1998 Institute of Physics Conference Series*, No. 162, 1999, pages 469-473

Document 2: JP 2002-43696 A (Fujitsu Ltd.), 8 February 2002, paragraphs [0028]-[0035], [0100]-[0114], fig. 7 (Family: none)

Document 3: JP 9-326506 A (Fujitsu Ltd.), 16 December 1997, paragraphs [0040]-[0051], fig. 15-17 (Family: none)

Document 4: US 2001-028755 A1 (Fujitsu Ltd.), 11 October 2001, paragraphs [0061]-[0082], paragraph [0109], fig. 6, 9, 10, & JP 2001-255500 A

Document 5: JP 2000-196065 A (Fujitsu Ltd.), 14 July 2000, paragraphs [0026]-[0030], [0056]-[0060], fig. 3, 8, 9 (Family: none)

Claims 1 to 30

Document 1 does not disclose a compound semiconductor characterized in that quantum dots have mutually differing compositions.

However, the double heterostructure wherein cladding layers having a bandgap greater than that of an active layer are provided on both sides of said active layer is a known quantum structure disclosed in documents 2 to 4, and moreover, the active layer and cladding layers of the semiconductor devices disclosed in documents 2 to 4 comprise compound semiconductors having constituent elements such as Ga or the like, which serve as a source of "meltback and mutual dispersion of the constituent elements of the compound semiconductor."

Accordingly, a person skilled in the art could easily conceive of applying the aforementioned double heterostructure to the quantum dots disclosed in document 1, thereby deriving an invention wherein there is "meltback and mutual dispersion of the constituent elements of the compound semiconductor."

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

(1) The meaning of the phrase "have a plurality of quantum levels," used in the statement of claim 1, wherein "the non-uniform quantum dots have a plurality of quantum levels corresponding to a plurality of wavelengths which include at least either of ultraviolet light to visible light or infrared light including the 1.3 μm band and the 1.5 μm band, and which with the input of electrical current, serve as the emission peak(s)," is unclear.

(It is unclear whether each individual quantum dot "has a plurality of quantum levels," or whether, in order that the quantum level of individual quantum dots be different, there exists a plurality of quantum levels for entire groups of multiple non-uniform quantum dots.)

(2) For the same reason, the meaning of the phrases "have a plurality of quantum levels" and "having a plurality of quantum levels" used in claims 2, 8, 9, 15, and 20 is unclear, and thus, it is not clear what the inventions described in claims 2 to 24 are.

(3) The description of the present application states that:

"[A]n $\text{Al}_{0.26}\text{Ga}_{0.21}\text{In}_{0.53}\text{As}$ layer (3b) is laminated onto the quantum dots (19) in a thickness of, for example, 5 to 10 nm. While this layer is being grown, meltback and mutual dispersion of the n-type cladding layer (5) and ... the constituent elements of the compound semiconductor serve to give the quantum dots (19) a composition that is not simply InAs, but

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VIII. Certain observations on the international application

claim 25 is unclear, and thus, it is not clear what the inventions described in claims 25 to 30 are.